DOCUMENT RESUME

ED 080 308 SE 015 981

AUTHOR McDuffie, Thomas E., Jr.; Bruce, Matthew H.
TITLE Predicting High and Low Success Group Membership in an A-T Biology Program.
PUB DATE Mar 73
NOTE 14p.; Paper presented at the annual meeting of the National Association for Research in Science Teaching (46th, Detroit, Michigan, March 1973)

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Academic Achievement; Attitudes; *Autoinstructional Programs; Biology; College Science; *Educational Research; Science Education; *Student Characteristics
IDENTIFIERS Research Reports

ABSTRACT

The study examined relationships between personal characteristics and achievement in and attitude toward an audio-tutorial (A-T) biology program. The central question of the investigation was: Is there a different profile for (1) high and low achievers, (2) students with positive and negative attitudes toward the instructional method, and (3) successful and unsuccessful students? The population studied consisted of 119 students in a one-year A-T biology program at Elizabethtown College, Pennsylvania. Eighteen variables were measured using standardized indices: CEEB scores, Nelson Biology Test, Moore's Scientific Attitude Inventory, and the Guilford Zimmerman Temperament Survey (GZTS), plus an attitude questionnaire developed for the study. Based upon an analysis of the results it was concluded that: (1) since the abilities, attitudes and personalities of the majority of students were compatible with A-T instruction, the approach provided a desirable alternative to large group instruction in biology; (2) personality factors on the GZTS were poor predictors of achievement and attitudes toward science and A-T instruction; and (3) the discriminant technqiue was better suited for predicting membership in high or low groups than was regression analysis. The techniques used in this study might provide a means of identifying students for whom the A-T method is an inappropriate instructional atlernative. (JR)

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PREDICTING HIGH AND LOW SUCCESS GROUP MEMBERSHIP IN AN A-T BIOLOGY PROGRAM

Thomas E. McDuffie, Jr.
St. Joseph's College
Philadelphia, Pennsylvania

Matthew H. Bruce
Temple University
Philadelphia, Pennsylvania

Presented at the

1973 NARST Annual Meeting

Detroit, Michigan

SE 015 981

The investigation being reported was basically a first-order, statistical probing of the audio-tutorial (A-T) method of instruction. The study examined relationships between personal characteristics and three indicators of success. The following questions summarize the focus of the investigation. What are the relationships between personal traits and achievement, attitude toward the instructional mode and attitude toward science? Is there a differential set of personal characteristics for: (1) high and low achievers; (2) students with positive and those with negative attitudes toward the instructional method; and (3) students high on both achievement and attitude, and those low on both these criteria.

Background

A three-part format is fundamental to the A-T approach to individualized instruction.[1] The components include (1) an Independent Study Session (ISS), (2) an Integrated Quiz Session (IQS), and (3) a General Assembly Session (GAS). The ISS is both the principal and unique component of the method. During this supervised session students, working at carrels, listen to taped presentations by a master teacher. Each session includes a multimedia lesson or minicourse based upon the instructional systems approach. In essence, students are guided through a series of investigations and discussions intended to present material in conceptual units. The IQS, a small group discussion meeting, can be used to evaluate student progress and to provide close, personal

contact between instructor and student. The GAS, a remnant of the traditional lecture-laboratory approach, is utilized to map out future work, fit portions of the course into a conceptual whole and to present guest lecturers or films.

Comparative, factorial and theoretically oriented studies have been based upon the A-T approach. Student achievement in an A-T format is generally greater than or equal to that associated with less individualized methods[1,2,3]. Also, the individualized format seems more efficient with regard to communicating formation[4,5] and to promoting student learning[3,6]. Moreover, students seem to prefer the A-T approach to more traditional classes[4,7,8].

While multi-variate studies have employed varied sets of predictors, several results have appeared repeatedly. First, aptitude, as predicted by SAT[2,7,8] or CEEB[9] scores, has been the best predictor of achievement. Second, personality factors exhibited only slight relationships to achievement[7,9]. Third, females tend to be higher achievers than males in A-T biology programs[2,8].

Significant departures from the comparative and correlational studies mentioned above have also been reported. An adaptation of Flanders' interaction analysis schemes has been used to relate teaching style to outcomes[10]. In addition A-T programs for elementary school science have been developed and field tested based upon Ausubel's learning theory[11].

Population and Program

Participants in the present investigation were enrolled in the second semester of a year-long A-T biology program at Elizabethtown College (Penna.) A 119 member sample, 35 males and 84 females, was included in the study. Comparisons between the sample and the 217 member population indicated that the former was representative with regard to sex and CEEB scores, but significantly skewed toward higher course grades.

Data was collected in stages throughout the spring semester and included a total of eighteen traits. The standardized indices included: College Entrance Examination Board scores, Nelson Biology Test, Moore's Scientific Attitude Inventory[12], and the Guilford Zimmerman Temperament Survey. In addition an attitude questionnaire was developed for the study.

High achievers were students whose scores on the biology test were in the top quarter of the group. Individuals whose scores on the attitude questionnaire were in the top quarter constituted the group with a positive attitude toward the A-T method. The low achievement and attitude groups had scores in the bottom quarters of the respective distributions. The third group, called the "success" group, consisted of the students in the top third on both achievement and attitude. Students in both lower groups were considered to be "unsuccessful".

Elizabethtown's A-T program, essentially an introductory biology course, included three phases: a general assembly session, an audio-tape session and a discussion meeting. In general, zoology and botany were emphasized during the first and second semesters respectively. The major topics considered during the first semester were (1) the diversity and unity of life, (2) cellular structure and function and (3) reproduction and heredity. The principal units included in the second semester were (1) plants — their structure, life cycles and forms —, (2) invertebrate biology, (3) anatomy and physiology of vertebrates and (4) man and his environment.

Data Analysis and Results

Data was analyzed in two stages. First, step-wise regression analyses were conducted utilizing the BMD02R program[14]. Second, comparisons between high and low success groups were made using step-wise discriminant techniques and the BMD04M program[14].

In conjunction with the analysis, the Attitude toward the A-T Method questionnaire's reliability and ability to discriminate were estimated. Odd-even half scores exhibited a correlation of 0.91 and a reliability of 0.96 — calculated using a technique designed for untimed tests[15]. The ability of each attitude statement to discriminate between high and low achievers was also examined. Comparisons of the means for the top and bottom quarters showed that responses on 20 of the 40 items differed at the .025 level or better. On this basis, the questionnaire appears to have

TABLE I

Summary of the First Five Steps
of the Regression Analyses*

CRITERION	ACHIEVEMENT		ATTITUDE TOWARD THE A-T METHOD		ATTITUDE TOWARD SCIENCE	
Step	Variable Removed	% Var.	Variable Removed	% Var.	Variable Removed	% Var.
1	CEEB Math	9.8	Ascendance	3.9	CEEB Math	7.7
2	Restraint	12.7	Sci. Emotional	6.2	Attitude (A-T)	12.4
3	Masculinity	15.1	Sci. Intellectual	7.9	Sex	15.0
4	Sex	17.2	Restraint	9.0	Masculinity	16.3
5	CEEB Verbal	18.4	Emotional Stability	9.6	Social Interest	16.7
Total Explained Variance		23.2		13.5		19.4

*When the battery was examined with respect to achievement, 9.8 percent of the variance was associated with CEEB mathematics. Upon removal of this variance and examination of the residual variance, 3.1 percent could be associated with restraint, or a total of 12.7 percent with the two factors.

TABLE II

First Five Steps of the
GZTS Achievement Regression Analysis

STEP	VARIABLE REMOVED	% VARIANCE
1	Masculinity	3.4
2	Restraint	6.5
3	Ascendance	8.5
4	General Activity	11.5
5	Friendliness	12.2
Total Explained Variance		13.1

adequate internal reliability plus some ability to distinguish between high and low achievers.

Regression Analyses

Step-wise regression analyses were conducted using achievement, attitude toward the instructional method, and attitude toward science as criteria. Each criterion was initially examined with regard to the full battery of predictors (Table I, P. 5), and then with regard to the factors on the GZTS (Table II, P. 5).

Of the three criteria variance among the Nelson Biology Test scores was most readily associated with the battery of factors. The full predictor model explained 23.2 percent of the variance in raw achievement scores. As the results reported by other investigators[2,7,8] suggested, aptitude, as defined by CEEB scores, was the best predictor of achievement. The CEEB mathematics factor accounted for 9.8 percent of the total variance ($p \leq .05$) but the verbal component adds little to the predictive equation. The personality factors most closely related to achievement were restraint and masculinity.

Since high correlations between CEEB scores and achievement were predictable, the variance associated with these aptitude measures was removed and the residual achivement scores examined with regard to the remaining factors. Masculinity, restraint, sex and general activity accounted for most of the 13.2 percent of the residual variance that was explained.

Minimal relationships were uncovered between predictors and the attitudes examined. The battery accounted for

19.4 percent of the variance among attitude toward science scores. CEEB mathematics and attitude toward the instructional method exhibited strong correlations with this dimension. On the other hand, a meager 13.5 percent of the variance on attitude toward instruction scores was associated with the set of factors, and most of this was attributable to scientific attitude.

When relationships between the GZTS and achievement were examined (Table II, P. 5), masculinity, restraint and ascendance were prominent. While no apparent theoretical base appears to explain the relationship involving restraint, Maccoby suggests that masculinity and ascendance are both related with aggression which, in turn, is associated with achievement[16].

Discriminant Analysis

A two-group, step-wise discriminant analysis technique involving the BMD04M program was employed to contrast high and low groups on achievement, attitude toward science and "success". In this approach the variance associated with the most discriminating factor is eliminated; then the residual variance is reexamined and the amount related to the next best predictor deleted. The discriminant equation is thus built up by adding the factor which explains the greatest amount or residual variance at each stage.

Results of the examination (Table III, P.) indicate that significant differences (p .05) existed between the mean vectors of high and low groups on each criterion. Most of the variance between group means on each criterion was associated with a principal variable. For achievement,

TABLE III

Summary of the First Five Steps
of the Discriminant Analyses

CRITERION	ACHIEVEMENT		ATTITUDE TOWARD THE A-T METHOD		ATTITUDE TOWARD SCIENCE	
Step	Variable Removed	Total F Value	Variable Removed	Total F Value	Variable Removed	Total F Value
1	CEEB Verbal	6.53*	Sci. Emotional	6.42*	CEEB Math	10.94*
2	Masculinity	6.09*	CEEB Math	4.09*	Sci. Emotional	8.04*
3	Attitude (A-T)	5.34*	Sci. Intellectual	3.08*	Masculinity	6.61*
4	Sex	5.06*	Ascendance	2.55*	Sci. Intellectual	5.74*
5	Restraint	4.64*	Friendliness	2.30	Emotional Stability	6.24*

*$p \leq .05$

TABLE IV

Percent of Students Correctly Assigned
to Groups in Post Hoc Analysis

GROUP \ CRITERION	ACHIEVEMENT	ATTITUDE (A-T)	"SUCCESS"
High	50	3%	13%
Low	94	73%	94%

attitude toward the method of instruction and "success" respectively, the principal variables were CEEB verbal, emotional components of attitude toward science and CEEB mathematics.

The discriminant functions derived during the analysis were used as the basis for ex post facto prediction of high and low group membership (Table IV, P. 8). Functions generated in the present investigation were generally more capable of predicting membership in the low group than in the high. Twenty-six of the twenty-eight low achievers were classified properly. Such a high proportion of the low achievers is particularly impressive when the skewing of the sample toward high achievers is considered. These results suggest that the battery of factors, calibrated for the individual program, might be employed to direct some students away from A-T programs and toward a more suitable instructional alternative.

Although significant differences were observed between high and low groups on attitude toward the instructional method, the ability of the battery to distinguish between groups was basically limited to CEEB mathematics and the intellectual component of attitude toward science. The results lead to several observations, however. First, attitude toward the instructional method and attitude toward science were closely allied. Second, verbal aptitude and achievement exhibited negligible associations with attitude toward the A-T method. Third, the discriminant function for achievement and attitude toward the A-T method were quite different.

The relative independence of achievement and attitude toward the A-T method make interpreting results based upon the definition of "success" hazardous. For example, while most of the traits lead to significant F values and post hoc prediction of seventeen out of eighteen "unsuccessful" persons, several individuals who were low on one criterion were high on another.

Summary and Conclusions

Results of the regression analyses indicate that the set of personal characteristics were associated with significant, but small amounts of variance on each criterion. Achievement was most strongly related to CEEB mathematics scores. Masculinity, restraint, ascendance and attitude toward instruction exhibited lesser relationships. A total of 23.2 percent of the achievement variance was accounted for by the battery. Less than 20 percent of the variance on the highly interrelated attitude measures was related to the factors. Discriminant analysis uncovered significant F values for each criterion; however, most of the variance was associated with a single variable. Post hoc predictions, based upon the discriminant functions, indicated that low group membership was more predictable than high. The functions correctly assigned 94 percent of the low achievers and better than 75 percent of the low groups on the other factors. Pronounced differences were found between achievement and attitude indicating that they are relatively independent dimensions. The most discriminating indices included CEEB scores and scientific attitudes. Attitude

toward the method was of secondary importance while the influence of personality factors, with the exception of masculinity and restraint was slight.

Conclusions

1. Since the abilities, attitudes and personalities of the majority of students are compatible with A-T instruction, the approach provides a desirable alternative to large group instruction in biology.
2. Personality factors on the GZTS are poor predictors of achievement and attitudes toward science and A-T instruction.
3. The discriminant technique is better suited for predicting membership in high or low groups than regression analysis.

Implications

1. Since the discriminant analyses indicated that low group membership had high post hoc predictability, particularly with respect to achievement, the battery and statistical techniques used might provide a useful means of guiding students away from the A-T method and toward a more suitable instructional alternative.
2. When an A-T program is implemented, an instructional alternative should be available to students who would be predictably unsuccessful in the independent format.

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